2017

Supplementary Data Report for 'Eddy Heat Flux Across the Antarctic Circumpolar Current Estimated from Sea Surface Height Standard Deviation'

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Eddy heat flux across the Antarctic Circumpolar Current estimated from sea surface height standard deviation

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Physical Oceanography Technical Report 2017.1

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May 31, 2017
http://digitalcommons.uri.edu/physical_oceanography_techrpts/6/

Abstract

These are supporting codes and files for the manuscript "Eddy heat flux across the Antarctic Circumpolar Current estimated from sea surface height standard deviation" that was submitted to JGR in February 2017 (Paper #2017JC012837), written by Annie Foppert, Kathleen A. Donohue, D. Randolph Watts, and Karen L. Tracey. The following document explains the codes used for analysis of the data used in the manuscript and files used to create the figures in the paper. The manuscript's abstract is:

> Eddy heat flux (EHF) is a predominant mechanism for heat transport across the zonally unbounded mean flow of the Antarctic Circumpolar Current (ACC). Observations of dynamically relevant, divergent, four-year mean EHF in Drake Passage from the cDrake project, as well as previous studies of atmospheric and oceanic storm tracks, motivates the use of sea surface height (SSH) standard deviation, H^*, as a proxy for depth-integrated, downgradient, time-mean EHF ($[\overline{EHF}]$) in the ACC. Statistics from the Southern Ocean State Estimate corroborate this choice and validate throughout the ACC the spatial agreement between H^* and $[\overline{EHF}]$ seen locally in Drake Passage. Eight regions of elevated $[\overline{EHF}]$ are identified from nearly 22.5 years of satellite altimetry data. Elevated cross-front exchange usually does not span the full latitudinal width of the ACC in each region, implying a hand-off of heat between ACC fronts and frontal zones as they encounter the different $[\overline{EHF}]$ hot spots along their circumpolar path. Integrated along circumpolar streamlines, defined by mean SSH contours, we find a convergence of $[\overline{EHF}]$ in the ACC: 1.06 PW enters from the north and 0.02 PW exits to the south. Temporal trends in low-frequency [EHF] are calculated in a running-mean sense using H^* from overlapping 4-year subsets of SSH. Significant increases in [EHF] magnitude are found at Kerguelen Plateau, Southeast Indian Ridge, and the Brazil-Malvinas Confluence, whereas the other five $[\overline{EHF}]$ hot spots have insignificant trends of varying sign.

1 Data files (.mat)

1.1 LdaEhfSshEke.mat

This file contains data from cDrake within two structured variables. 'lda' contains the $[\overline{EHF}]_{cDrake}$ vectors and magnitude, SSH mean and its standard deviation, surface EKE, and comments on units and calculations. 'oigrid' is the grid used in optimal-interpolation mapping of the CPIES data.

1.2 DivergenceCurl.mat

This file contains the curl and divergence of the total, baroclinic, and reference EHF. This file goes with the OI mapping grid.

1.3 StitchedMeanFeilds_NEW.mat

This file contains the time-mean fields of quantities calculated in SOSE, with a note ('NB') explaining what each is. Mean SSH, its standard deviation, depth-integrated EHF vectors, geostrophic velocity and surface EKE, and the index of the reference level are all included. This file goes with the SOSE grid.

1.4 downgradientpowerlawfit_NEW.mat

This file contains a structured variable called 'powerlaw' that contains all the information used to calculate the power law fit in SOSE. The bin-averaged values and the slope and intercept of the line in log-log space and the statistics on the fit, as well as the path-integrated values and the residual between the $\oint[\overline{EHF}]_{SOSE}$ and $\oint[\overline{EHF}]_{SOSE-fit}$ are all contained within this .mat file. This file goes with the SOSE grid.

1.5 downgradientEHFfit2satellite_23yearSSH.mat

This file contains a structured variable called 'satfit' that contains the power law fit to satellite SSH data. The mean SSH and its standard deviation, the $[\overline{EHF}]_{sat}$ and $\oint[\overline{EHF}]_{sat}$, and surface geostrophic speeds are all contained within this .mat file. This file also contains the satellite grid.

1.6 hotspots_indices_23yearSSH.mat

This file contains eight structured variables, one for each of the $[\overline{EHF}]_{sat}$ hot spots found in this study. Within each structured variable are the longitudal and latitudinal indices (x,y) that correspond to the limits of the hotspot on the satellite grid and its mean $[\overline{EHF}]_{sat}$ for values less than or equal to -10 MW m^{-1}.

1.7 hotspots_indices_andQ_23yearSSH.mat

This is the same file as above, but also includes the % of the total $\oint[\overline{EHF}]_{sat}$ along the 5 circumpolar mean SSH contours presented in the manuscript.

1.8 qtrends_23yearSSH_4YRchunks.mat

This file contains information form the eight hot spots found in this study embedded within two structured variables ('qtrend' and 'qtrendbw') with the same $[EHF]_{sat}$ timseries anomaly in each. The difference between the two variables is in how the trends were calculated: the former does not include the most recent data and stops after the last full 4-year subset of time was used such that it goes through the end of 2014, the latter includes the most recent 4-years of data but with a different overlap than the 2-year overlap of all the other subsets of time. The trends in 'qtrend' were cited in the manuscript.

2 Analyses and figure-making codes (.m)

2.1 cDrakeMap4paper.m

Creates Figure 1.

2.2 pltcDrake_UtotUbcbUref_curldiverg.m

Creates Figure 2.

2.3 QacrossmeanSSH.m

Calculates the power-law fit and creates downgradientpowerlawfit_NEW.mat.

2.4 soseMAPS_sshstdev_ehf.m

Creates Figure 3.

2.5 SOSEpowerLaw_circumpolarIntegral.m

Creates Figures 4 and 5.

2.6 QacrossmeanSSH_fit2AVISO_23yearSSH.m

Applies the power-law fit to satellite SSH data and creates downgradientEHFfit2satellite_-23yearSSH.mat.

2.7 defineHOTSPOTS_23yearSSH.m

Defines $[\overline{EHF}]_{sat}$ hotspots and their lat-lon limits, and creates hotspots_indices_23yearSSH.mat.

2.8 satelliteFITehf.m

Creates Figures 6 and 7, Table 1, and hotspots_indices_andQ_23yearSSH.mat.

2.9 aviso_ssh_trend_23yearSSH.m

Calculates the running mean $[EHF]_{sat}$ time series anomaly and temporal trends in each of the eight $[\overline{EHF}]_{sat}$ hotspots, and creates qtrends_23yearSSH_4YRchunks.mat.

2.10 trends_map.m

Creates Figure 8.

2.11 myFavStormTracks_23yearSSH.m

Creates Figure 9.